Studies on Sensory Deprivation: VI Part 1. General Methods, and Results of polygraphic Records, behavioral Observation and Interviews

STUDIES ON SENSORY DEPRIVATION: VI

PART 1. GENERAL METHODS, AND RESULTS OF POLYGRAPHIC RECORDS, BEHAVIORAL OBSERVATIONS AND INTERVIEWS

By

TAKAYOSHI KATO (加藤孝義), HIROKO TANAKA (田中弘子), HIDEOKI TADA (田多英興) and TOSHITERU HATAYAMA (畑山俊輝)

(*Department of Psychology, Tohoku University, Sendai*)

In the introduction to a series of papers, general viewpoint and methods of the present study are described. Next, the results of polygraphic records, behavioral observations and interviews are reported. Present experiment was performed under the condition of 24 hrs. sensory deprivation, using 12 Ss of male undergraduate students as subjects. Results reaffirmed by and large our previous findings and some data illustrated the findings more clearer than ever before.

Introduction

In our previous papers, we have suggested that the various results of sensory deprivation experiment are attributed to the different natures of the functions in the organism, rather than to the differences of the experimental conditions, and moreover these results should be discussed in terms of the relationships among these different functions in the organism. Further, we pointed out that these different functions of the organism could be divided into two 'Schichten', that is, the higher system and the lower system, and the functions of the former are deteriorated, while those of the latter are facilitated by the sensory deprivation (1, 2, 3, 4, 5).

In the present study, besides the general improvements of the experimental procedures, some efforts were made in order to re-examine our previous hypothesis, that is, a few new tests were added, and the tests whose results had been uncertain were re-tested, with some modifications.

Method

Procedure: The experimental procedures for controlling the sensory input were almost the same with those of previous study and the aim of the present experiment was also to prevent the patterning of sensory stimulations. In the present experiment, sensory deprivation lasted for 24 hrs. The experimental confinement began in principle at 2.00 p.m. For the purpose of administering as many tests as possible, each test of recall, immediate memory, association and test of synesthesia were introduced 21 hrs. after the beginning of sensory deprivation at intervals of 30–40

minutes by interphone system, and then the confinement was again continued for the planned period. After the cessation of the confinement, the following tests were given in order of administration, 1) C.F.F., 2) size constancy, 3) Motokawa's method of electric flicker, 4) retinal rivalry, 5) performance test, 6) Szondi test, 7) self-concept, and 8) interview. These tests were given twice in principle, before and after the sensory deprivation. It took about 2 hrs. to finish all the tests from the cessation of the confinement to interview. Besides these tests, Ss' all activities during sensory deprivation were observed through TV-camera or other instruments, and polygraphic records such as EEG, ECG, SPR and respiration were recorded during the sensory deprivation period.

The experimentation was carried out from the end of July to the beginning of August 1966.

Subject: Ss were 12 male undergraduate students who were publicly collected in one university. Their age ranged from 18 to 19, and the mean age was 18.2. None of 12 Ss refused to stay in the experiment room, but 1 out of them rejected to stay in it, several hours after the beginning of the sensory deprivation. Ss of the control group were 15 male undergraduate students of the same university as those of the experimental group.

Results

1. EEG

Purpose: In our previous study, it was found that EEG after sensory deprivation showed a slight slowing tendency of alpha, and the changes of EEG in frontal lobe were different from those in the occipital. However, the brain waves of these 2 regions were not analyzed simultaneously, that is, first the brain waves of frontal lobe were integrated for 1 minute by a frequency analyzer, and after then those of occipital were done similarly as in the frontal lobe. Therefore, in the present study, it was aimed to verify more completely the results of previous study by integrating the brain waves of the frontal and occipital regions simultaneously.

Procedure: EEG was taken from the electrodes on the scalp of L-FL and L-OL with monopolar recording. Brain waves of both L-FL and L-OL were analyzed simultaneoulsy into delta (0–4 cps), theta (4–8 cps), alpha (8–13 cps), beta 1 (13–20 cps), and beta 2 (20–30 cps). EEG of each lobe was measured for 1 minute before and after sensory deprivation, and it was also recorded for 1 minute at 30 minute intervals during sensory deprivation. The data were examined for 8 Ss.

The results of analyses of EEG data which were measured in the states of Ss' awakenings were compared among the integrated values of 10 hrs. after the beginning of the confinement (During 1), about 20 hrs. after it (During 2), and after the sensory deprivation.

Results: Fig. 1-a and 1-b show the results of the comparisons among the data, before and

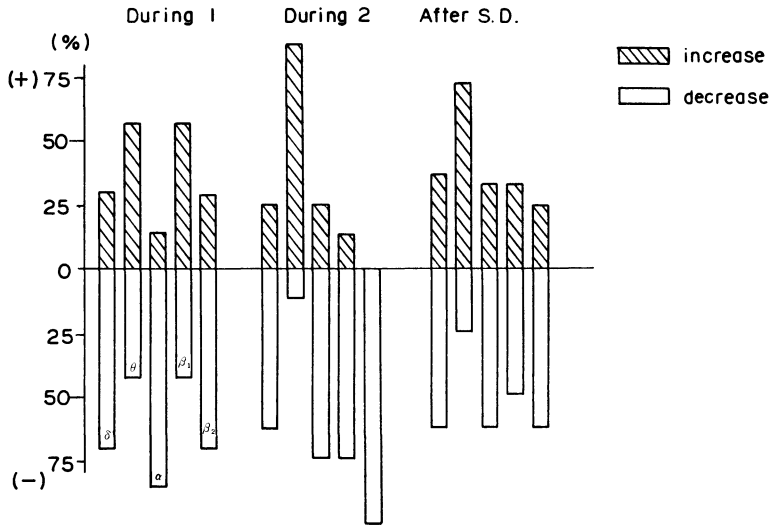

Fig. 1-a. Percentages of Ss showing the decrease or increase in the integrated values of L-FL EEG before and after sensory deprivation.

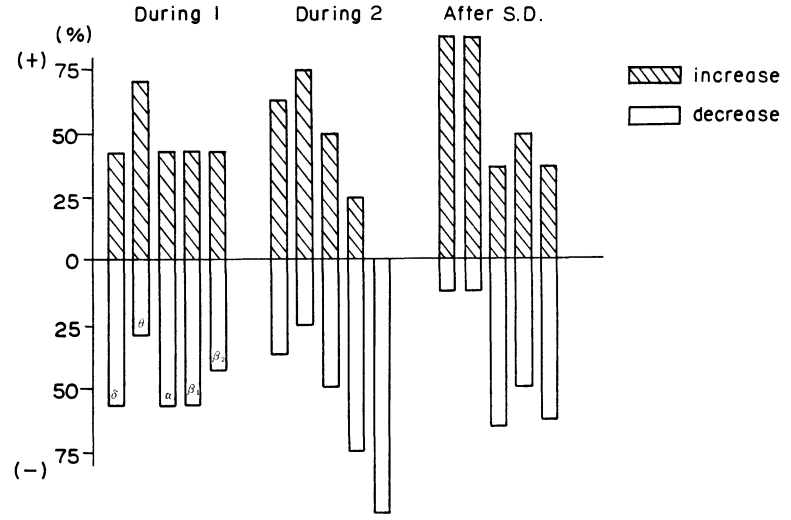

Fig. 1-b. Percentages of Ss showing the decrease or increase in the integrated values of L-OL EEG before and after sensory deprivation.

during 1 and 2, and after the sensory deprivation. The graph presents the percentages of Ss showing a decrease or increase of each wave to EEG of pre-confinement. In this figure, it was found that in FL, alpha of During 1 decreases and especially faster waves than alpha in During 2 decrease extremely, and on the contrary, theta of During 2 increases remarkably. In each wave, EEG of post-sensory-deprivation was similar to

that of EEG of pre-sensory-deprivation, but theta of it showed an increase. In OL, theta of During 1 and 2 showed a decreasing tendency, but betas of the same periods showed an increasing tendency, and betas of EEG of post-confinement were similar to those of EEG of pre-confinement in their percentages. The difference of the slowing tendencies of alpha between OL and FL was not verified in the present experiment.

As seen in Fig. 2, it was also ascertained in the present study that a slowing tendency of alpha waves was seen after sensory deprivation. That is, it was found that the M_0 of alpha waves after sensory deprivation shifted to the lower cycle than that of EEG before sensory deprivation.

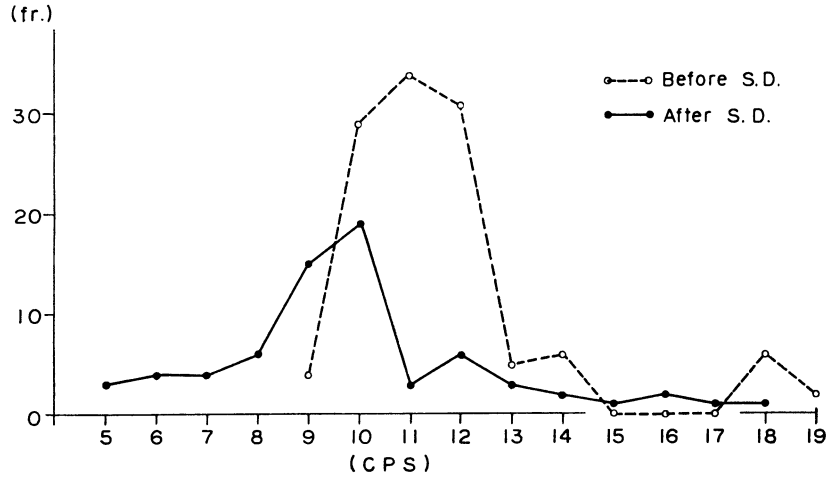

Fig. 2. Comparison of alpha waves before and after sensory deprivation.

2. Skin potential response (SPR)

It has been said that SPR of mental sweating is different from that of thermal (sweating) in its manifestation. Therefore, in the present study, it was aimed to examine the difference of the manifestations of these 2 kinds of SPRs in sensory deprivation.

Procedure: SPR was recorded using Zn-Zn SO_4 electrodes. They were filled with kaolin paste and attached, using adhesive tape, to skin surfaces previously cleaned with aceton. Electrode pair of thermal sweating was formed with both electrodes on the forearm, but active electrode site of them was done no skin preparation. One of this pair of mental sweating was on the hypothenar eminence (active electrode), and the other on the forearm or occasionally also on the auricle (inactive electrode). SPR was measured by the potential method, after each EEG measurement. Paper speed

of recording was 0.5 cm per second.

Results: Fig. 3 presents a case where recordings of SPR can be obtained continuously during sensory deprivation. In this figure, SPR of mental sweating was compared with that of thermal sweating, by making it correspond to the stages of consciousness which were decided by both EEG and behavioral observations. In the figure, it is seen that 2 modes of SPR's manifestations during sensory deprivation don't necessarily support the hypothesis that when Ss awake, SPR of mental sweating appears dominantly than that of thermal, while on the contrary, when S is in sleep, the reversed result is observed. However, when the frequencies of the manifestation of these 2 kinds of skin potential waves (SPW) for 1 minute in each conscious stage were summed up, as seen in Fig. 4, SPW of mental sweating in awakening appeared more dominantly than that of thermal, while in sleep, the opposite result was obtained. In drowsiness, however, the difference of them is not clear. Fig. 5-a, 5-b, and 5-c are the records of SPRs of several cases. Fig. 5-a is a SPR in awakening. Electrode pair of A was formed with one electrode on the hypothenar eminence (different electrode site), and the other on the auricle (indifferent electrode site). The different electrode of that of B was on the forearm, and the indifferent one of that was also on the auricle. In awakening, SPW of hypothenar eminence (mental sweating) manifested, while that of the forearm didn't appear. SPR of B mixed with ECG. Fig. 5-b is a SPR in drowsiness. Electrode pair is similar to that of the case of Fig. 5-a. Manifestation manners of 2 kinds of SPRs are similar to each other. However, there is a difference between them, i.e., the amplitude changes of the potential of the hypothenar eminence are larger than those of the forearm. Fig. 5-c is also a SPR in sleep. As seen in the figure, SPR of the forearm is manifested more dominantly than that of the hypothenar eminence.

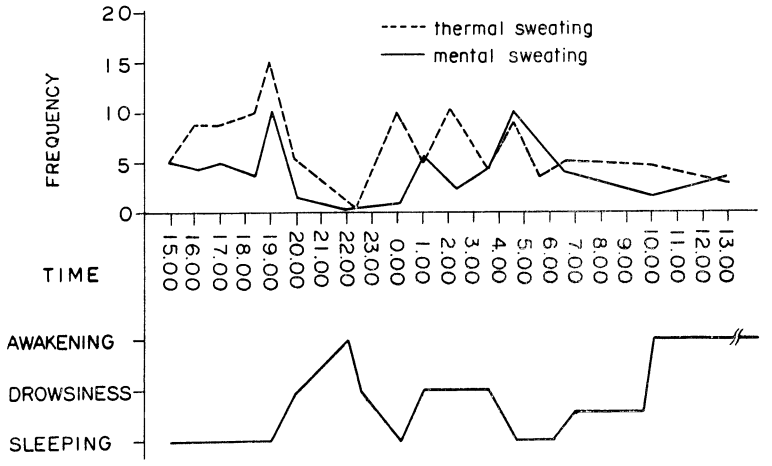

Fig. 3. Comparison of 2 kinds of spontaneous potential waves in each conscious stages during sensory deprivation.

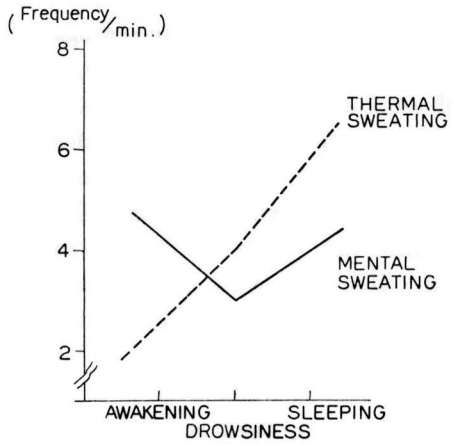

Fig. 4. Comparison of 2 kinds of SPRs in each conscious stage.

3. Behavioral observations

Fig. 6 shows the changes of 11 Ss' conscious stages during sensory deprivation. The figure was obtained from both EEG recordings, and behavioral observations which were vigilantly observed by 2 observers during sensory deprivation. The conscious stages of Ss were operationally divided into 3 stages of awakening, drowsiness and sleep.

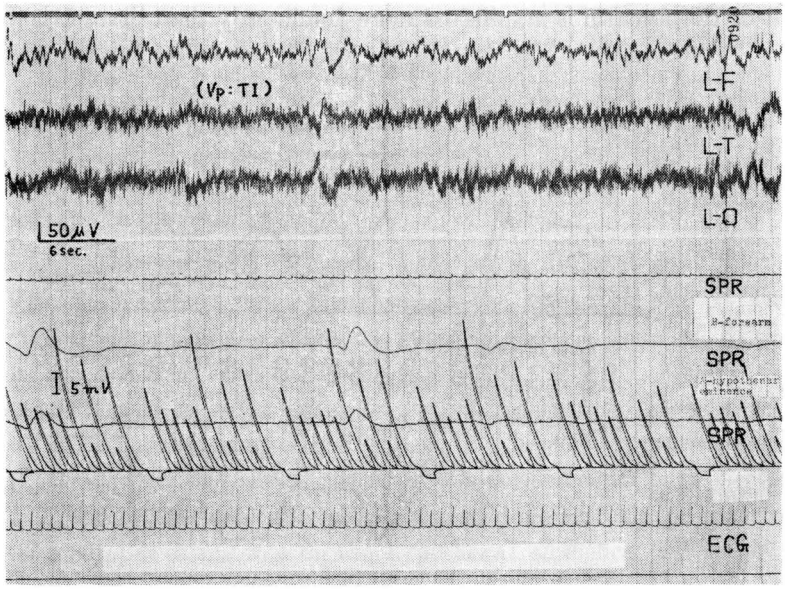

Fig. 5-a. Comparison of SPRs in awakening during sensory deprivation.

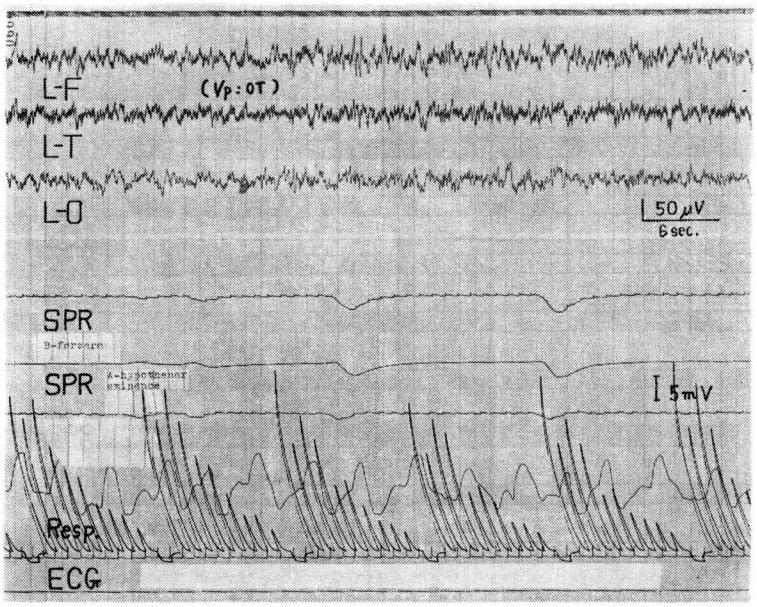

Fig. 5-b. Comparison of SPRs in drowsiness during sensory deprivation.

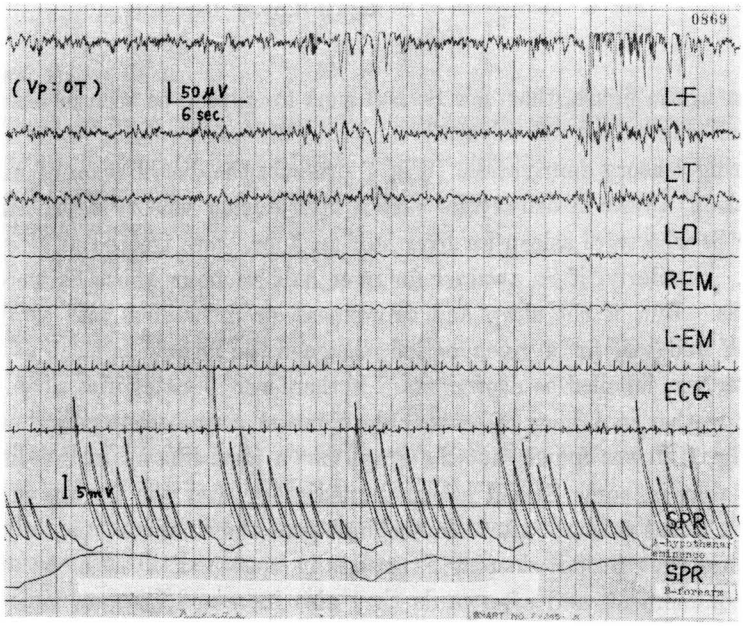

Fig. 5-c. Comparison of SPRs in sleeping during sensory deprivation.

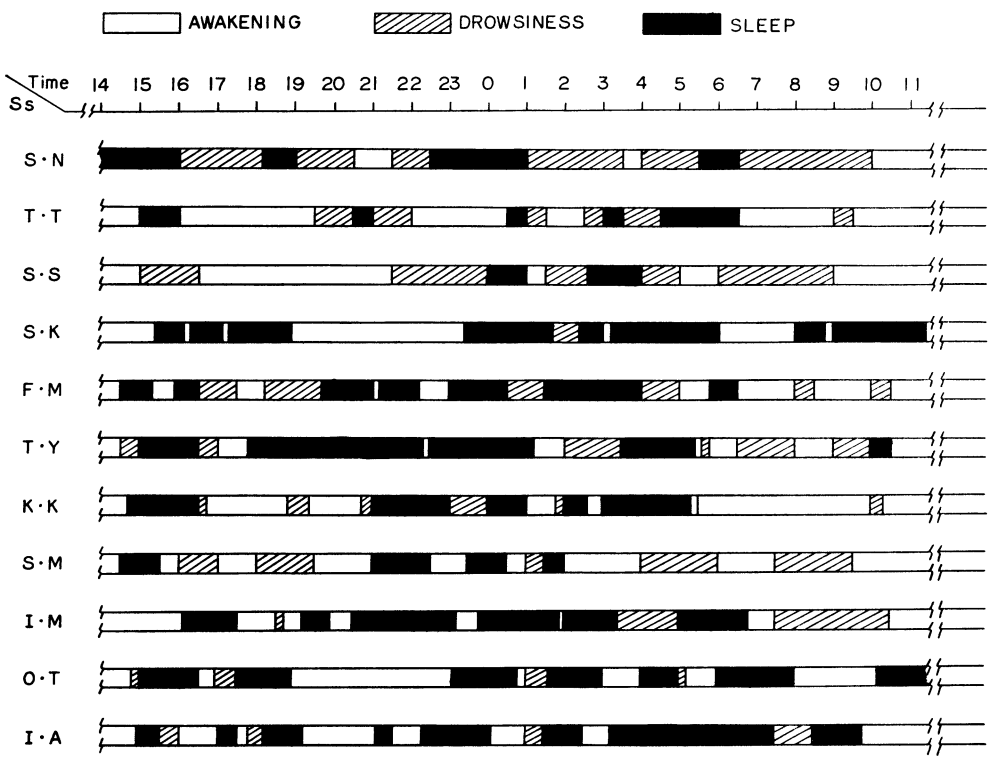

Fig. 6. Actograms of Ss during Sensory Deprivation.

There is seen in the figure, that few Ss had such long sleep as seen in natural sleep of daily life, and the stages of Ss' awakening and sleep, therefore, were several times repeated during sensory deprivation. Fig. 7 presents the distribution of number of Ss who were asleep, awake or drowsy for each 1 hour during sensory deprivation. In the figure, those Ss who were asleep for over half an hour, were treated as sleeping at that time period. Similarly, if Ss awaked for over half an hour, those Ss were treated as awakening Ss. But, if the sleep and drowsiness, or drowsiness and awakening were observed half and half for a given period, assigned the former as sleep at that period, and the latter was labelled as drowsiness. If there were 3 categories sleep, drowsiness, awakening together in 1 hour of sensory deprivation period, that period was omitted. From the Fig. 7, it was found that the graph has a form like W in the distribution of sleeping Ss, that is, some Ss fell asleep immediately after the beginning of the confinement, but about 5 hours after the beginning of the confinement, only 1 S was in sleep, and after that period, sleeping Ss gradually increased till 1 o'clock of the second day of the confinement, and afterwards they also increased for some time and decreased again at 7 o'clock of that day.

Now, in EEG of sleep during sensory deprivation, the stage of deep sleep didn't

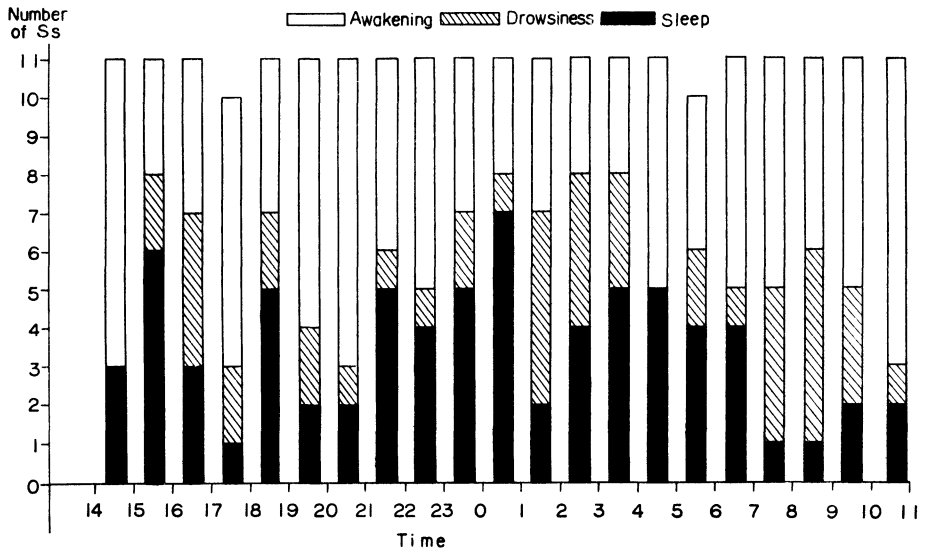

Fig. 7. Distribution of Ss in each conscious stage during sensory deprivation.

continue so long as in natural sleep, and no chance was given for us to see the paradoxical sleep in our study. On this paradoxical sleep, we intended several times to inspect its manifestation by measuring EEG all night, but we had no chance to observe such phenomenon in our experimental condition.

4. Interviews

In interviews, Ss were asked to introspect their experiences during sensory deprivation. Main items of question at interview were as follows:

1) Physical symptoms
2) Emotional states
3) Time estimation
4) Hallucinatory experiences
5) Attitude to the experiment
6) Free conversation

Results: Answers to each item were as follows:

1) Contents of Ss' appealings about 1) were described below. 'Thirsty' (7/11 Ss), 'hungry' (6/11), 'sweat' (8/11), and 'fatigue' (11/11).

2) General feelings of Ss in sensory deprivation were unpleasant (11/11), and they were rather calm, but tensive in some degree (7/11). Moreover, they were anxious (8/11).

3) Ss were asked to answer the following questions 21, 22 and 23 hrs. after the beginning of the confinement and at the cessation of it: What time is it now? As was

verified in our previous studies, it was also proved that Ss' subjective time estimations were less than the objective time. In some cases, it was seen that the time estimation reported at the first question or subsequent first or second was larger than the time estimation of the following questions.

4) Unusual experiences such as hallucinatory ones were reported more frequently in audition than in vision. These results are similar to our previous findings.

5) The motive of the applicants to sensory deprivation experiment was curiosity to it. Before the confinement, 5 Ss out of 11 applicants had the intention to spend the term of the confinement in sleeping, other 6 Ss had no particular motive to the experiment. But at the beginning of the confinement, Ss who intended of spending the confinement period in sleep increased to 8 Ss. However, after the confinement, only 2 Ss reported that they slept well during sensory deprivation. Most Ss frequently repeated the states of sleep, awakening and drowsiness.

Now, Ss did some thinking during the confinement, but they could not settle it in a system.

6) About the impressions of the experiment. Ss reported that they were irritated because of the loss of temporal orientation, and they felt the confinement as lonely, boresome, and painful.

References

(1) Kitamura, S. et al., Studies on sensory deprivation: I. Primary studies. *Tohoku Psychologica Folia*, 1963, 12, 1–39
(2) Kitamura, S., et al., Studies on sensory deprivation: II. *Tohoku Psychololologica Folia*, 1964, 22, 57–89
(3) Kitamura, S., et al., Studies on sensory deprivation: III. *Tohoku Psychologica Folia*, 1965, 23, 53–81
(4) Kitamura, S. et al., Studies on sensory deprivation: IV. *Tohoku Psychologica Folia*, 1965, 24, 1–37
(5) Kitamura, S. et al., Studies on sensory deprivation: V. *Tohoku Psychologica Folia*, 1966, 25, 1–31
(6) Martin, I., and Venables, P.H., Mechanisms of palmar skin resistance and skin potential, *Psychol. Bull.*, 1966, 65, 347–357
(7) Wang, G.H., The neural control of sweating, The University of Wisconsin Press, 1964
(8) Broughton, R. Poiré, and Tassinari, A., The electrodermogram (Tarchanoff effect) during sleep, *Electroenceph. clin. Neurophysiol.*, 1965, 18, 691–708
(9) Venables, P.H. and Soger, E., On the measurement of the level of skin potential, *Brit. J. Psychol.*, 1963, 54, 259–260

(Received September 15, 1967)

Zusammenfassung

Als die Einführung zu den folgenden Aufsätzen werden der allgemeine Gesichtspunkt und die Methode beschrieben. Dann, werden die Versuchsergebnisse der polygraphischen Aufzeichnungen, der Verhaltensbeobachtungen und der Besprechungen berichtet.

Die sinnlichen Entziehung (sensory deprivation) dauerte 24 Stunden. Als Versuchspersonen dienten 12 Studenter. Die Ergebnisse bestätigten unsere frühere Studien.